USAF Scientific Advisory Board

Quick Look Study

FY 2005

System-of-Systems Engineering for Air Force Capability Development

Terms of Reference

Background

Inadequate application of systems engineering principles and processes is the rationale used to explain why acquisitions are behind schedule, over budget, and deficient in required functionality. Yet, the current state of system engineering does not adequately support the development of complex, adaptive, and software-intensive system-of-systems (SoS)[1] in which humans are parts of the system. While capabilities-based justification of operational need, such as supported in the CRRA process, is a step in the right direction, there is no well established SoS methodology and associated tools and techniques that can support faster engineering analysis and realization of required capabilities. We need a methodology that can match operational tempo – that can quickly field 'good enough' systems that can be further developed and supported concurrent with their operational test and use. The existing tools and processes are often focused on a very limited number of narrow, pre-defined alternatives and lack the fidelity, agility, and integration necessary to provide responsive, comprehensive analysis of alternatives. The Air Force needs to build an understanding of the critical developmental and research needs in the (system) engineering of systems-of-systems.

Study Products

Briefing to SAF/OS & AF/CC by August 2005. Publish report by December 2005.

Charter

This quick look study will propose an engineering methodology, tailored for use by the Air Force, for software intensive SoS development with the dual goals of engineering a robust and adaptable SoS that:

(1) Provides validated operational capabilities; and
(2) Is delivered at a cycle time synchronous with current operational tempo.

The engineering methodology will leverage:

(1) Existing (and sometimes unused) sound systems engineering principles,
(2) Existing (and sometimes very successful) creative, non-traditional, innovation driven acquisition processes,

[1] A system will be called a System of Systems (SoS) when:
- The component systems achieve well-substantiated purposes in their own right even if detached from the overall system;
- The components systems are managed in large part for their own purposes rather than the purposes of the whole;
- It exhibits behaviors (including emergent ones) not achievable by the component systems acting independently;
- Functions, behaviors and component systems may be added or removed during its use.

(3) Operator derived expectations for systems engineering outcomes as exhibited among warfighters with field experience on SoS solutions, and
(4) Evolving research results in executable, model-based architecture to support concurrent discovery of requirements, simulatable and testable SoS representations, analysis and design of SoS architecture, and rapid transformation into fieldable capabilities.

The study will be scoped to focus on an exemplar area based on Air Force needs: e.g., (1) the integration of information operations capabilities into the CAOC; or (2) use of modeling and simulation for joint operational testing.